IS 11620 (1986): Recommended practice for ultrasonic testing and acceptance for plain carbon and low alloy forging quality steel blooms [MED 17: Chemical Engineering Plants and Related Equipment]

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UDC 66·047 : 006·76

(Reaffirmed 2003)

Indian Standard

CODE OF PRACTICE FOR FLUID BED DRYER

Chemical Engineering Sectional Committee, EDC 57; Drying Equipment Subcommittee, EDC 57 : 7 [Ref : Doc : EDC 57 (4261)]

1. Scope — Covers fluid bed dryers which are commonly used for relatively coarse granular and free flowing material.

2. Terminology — For the purpose of this standard, the following definitions shall apply.

2.1 *Capacity* — Shall imply the quantity of solid material produced or volatile liquid removed from wet feed under the stipulated conditions of quality. In case of fluidized bed dryers it can be expressed for continuous unit as:

a) The quantity (kg) of dried material per unit time (h) within stipulated volatile contents at the inlet and outlet of the dryer.

b) The quantity (kg) of volatile liquid removed per unit time (h) within stipulated volatile content at inlet and outlet of the dryer.

For batch fluidized dryer the capacity is usually defined as the weight of the wet material charged or dry material produced or liquid evaporated per batch.

2.2 *Constant Rate Drying* — Usually occurs in the initial stage of drying of wet material during which period of time the evaporation rate remains constant and the bed material is at constant wet bulb temperature of incoming gas.

2.3 *Critical Moisture Content* — is the moisture content at a particular time during the drying process when the constant rate drying phase ends and the falling rate drying phase starts.

2.4 *Dry Basis* — is the representation of the moisture content in the product obtained by dividing the mass of volatile liquid by the mass of absolute dry matter. It is generally expressed as percentage.

2.5 *Drying Curve* — is a graphical representation of the volatile content (dry basis or wet basis) of product versus time during the process of drying. Drying curve identifies the constant rate, falling rate regimes of drying.

2.6 *Drying Rate* — The rate at which wet material loses volatile liquid under drying condition. The drying rate is often divided into constant rate and falling rate periods, expressed in volatile liquid loss per unit time.

2.7 *Drying Time* — The time required to reduce a product from one volatile content to a lower volatile content based on experimental or practical conditions.

2.8 *Equilibrium Moisture* — The moisture content of the product when the product is in equilibrium with surrounding atmosphere is known as equilibrium moisture. The relative humidity of the surrounding atmosphere at the same condition is the equilibrium relative humidity at the particular temperature.

2.9 *Evaporation* — The change of liquid to gas which occurs at the surface of liquid.

2.10 *Falling Rate Drying* — The period of drying in which the rate of drying, the change of moisture with time is decreasing with time, is termed as falling rate drying.

2.11 *Feed* — Wet input material to the dryer is termed as feed.

2.12 *Final Moisture Content* — A representation of the moisture control of a product leaving a dryer is termed as final moisture content of product moisture and is expressed as dry basis or wet basis.

2.13 *Fines* — Small diameter particles in feed or those which form from larger particles during handling and drying. The fines may be carried by the drying gas.

2.14 *Fluidized Bed Dryer* — A unit for drying in which the product is in suspension.

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2.15 *Fluidization Velocity* — The operating gas velocity, which is higher than minimum fluidization velocity at which the fluidization and drying of bed particles occurs.

2.16 *Free Moisture* — The water in a substance not held by hygroscopic forces.

2.17 *Hold-up* — Total weight of the material held in the dryer at any time of operation.

2.18 *Hygroscopic* — Describes a material which gains or loses moisture depending upon the product, and the humidity and temperature of the surrounding environment.

2.19 *Minimum Fluidization Velocity* — The gas velocity at which the bed of solid particles is on the verge of fluidization is termed as minimum or incipient fluidization velocity.

2.20 *Moisture Content* — The weight of moisture in a product per unit weight of the product. It is usually expressed as dry basis or wet basis.

2.21 *Retention Time or Residence Time* — is the time taken by the product to travel from feed end to the product discharge end. Or in other words the time spent by the solid particle in the dryer.

3. Nomenclature — The various components of the fluidized bed dryer shall be designed as per Fig. 1.

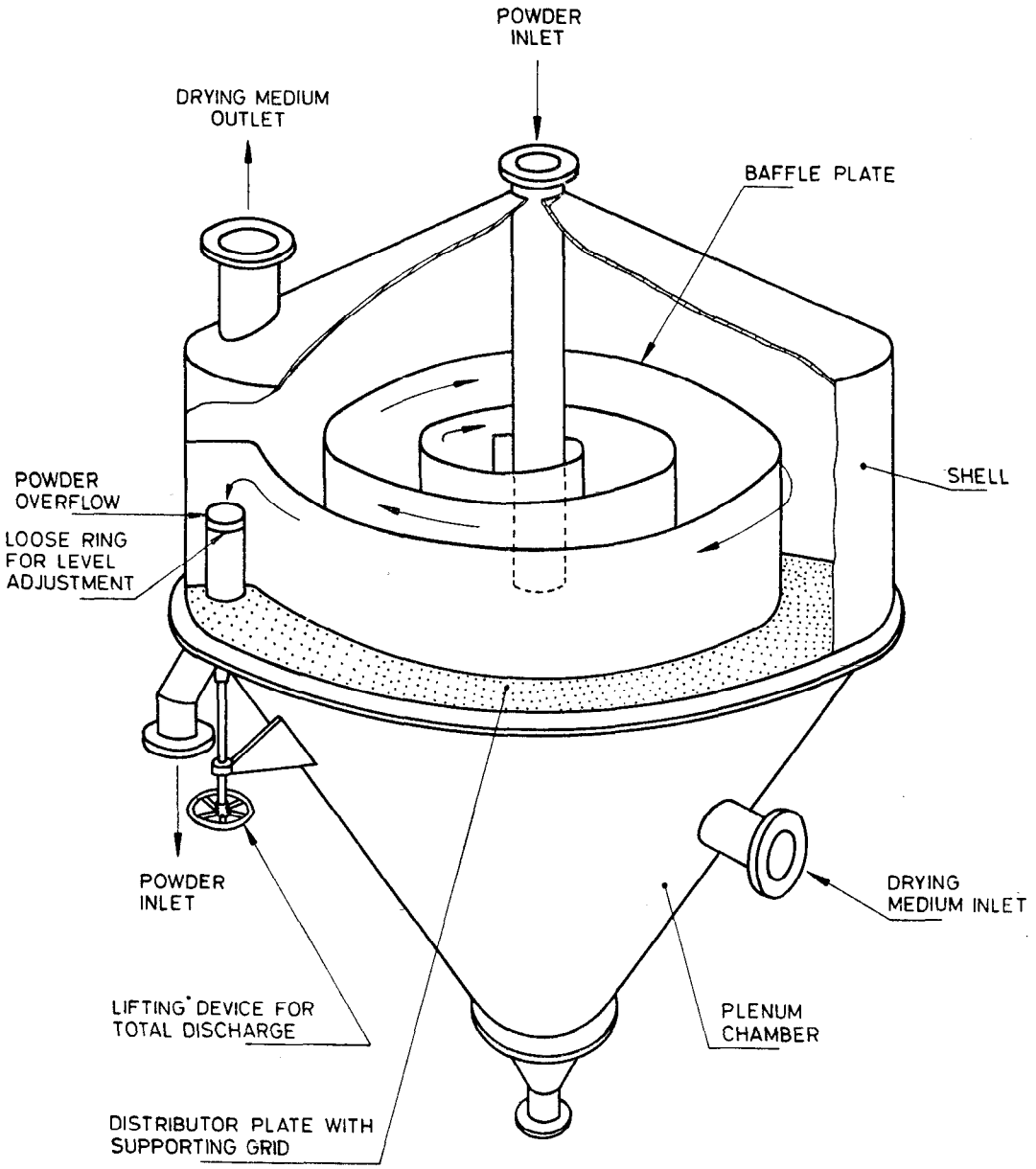

FIG. 1 NOMENCLATURE OF FLUID BED DRYER

4. Classification

4.1 Fluidized bed dryer shall be classified.

4.1.1 *Based on operation as*

a) Batch type where the charge to be dried is loaded into the dryer and is removed after the drying is over,

b) Continuous – Where the wet feed continuously enters the dryer and the dry product leaves the dryer at constant rate.

4.1.2 *Based on mode of heat supply*

a) Conventional convective heat dryers — Where the heat required for drying is supplied by gas.

b) Contact fluidized bed dryer — Where part of the beat required for drying is passed through heating surface embedded in the fluidized bed.

4.1.3 *Based on the fluidization method*

a) Cenventional static fluidized bed — Where the fluidization of particles takes place by the fluidizing gas only.

b) Vibrated fluidized bed – Where the fluidization of solid particle is achieved by the combined effect of vibrations and gas flow.

4.1.4 *Based on type of volatile solvent present*

a) Open cycle fluidized bed dryer — Where a low volatile usually water is present as a solvent and recovery of the solvent is not called for.

b) Closed cycle – Where there is a recycle of an explosive mixture of volatile solvent with oxygen content of air and where the recovery of solvent is must.

5. Sizes

5.1 Size of fluidized bed dryer shall be denoted by the diameter or length, breadth and height of the shell. Usually the cross-section area of the fluid bed is a representation of size of fluid bed dryer. The following gives a typical calculation for continuous fluidized bed dryer:

$$A = \frac{Q}{V \times C_p \times (T_{in} - T_{out})}$$

where

A = fluidized bed area, m^2;
Q = heat required for drying, J;
V = operating fluidizing gas velocity, m/h;
C_p = specific heat of fluidizing gas, J/kg·K;
T_{in} = inlet gas temperature, K; and
T_{out} = outlet gas temperature, K.

For cylindrical unit with diameter D(m)

$$A = \pi/4D^2$$

and for rectangular fluidized bed unit with length L(m) and width B(m)

$$A = L \times B$$

5.2 The size of gas distribution plate usually perforated plate has the same overall dimension as that of the cross-section of the fluidized bed, however, the diameter and pitch of the holes depending upon the designer and the product are determined from the selected percentage open area from following equation:

For square pitch

$$f = 100 \times \frac{\pi/4d^2}{p^2} = 78{\cdot}5\left(\frac{d}{p}\right)^2$$

For triangular pitch

$$f = \frac{1/2\ (\pi/4d^2)}{\sqrt{\frac{3}{4}}p^2}$$

$$= 90{\cdot}5\left(\frac{d}{p}\right)^2$$

where

f = percent open area of plate,
d = diameter of hole (mm), and
p = pitch of holes (mm).

6. Material of Construction — The material of construction for various components of fluidized bed dryer will depend upon the duty requirements. Table 1 gives a list of the same as per general practice.

TABLE 1 MATERIAL OF CONSTRUCTION

Sl No.	Component	Material Specification	Remarks
1.	Main shell	a) IS : 2062-1980 'Specification for structural steel (fusion welding quality) (*second revision*)'	
		b) Stainless steel according to IS : 6911-1972 'Specification for stainless steel plate sheet and strip'	
2.	Perforated plate	Stainless steel according to IS : 6911-1972	
3.	Supporting grid	IS : 2062-1980 IS : 6603-1972 'Specification for stainless steel bars and flats'	

7. Marking — The manufacturer shall provide a nameplate of a suitable corrosion resistance material, securely attached to the dryer in a position that is accessible and, if the dryer is to be lagged where it will not be obscured, stamped with the following information:

a) Manufacturer's name,

b) Manufacturer's serial number and identification, and

c) The number of this standard.

EXPLANATORY NOTE

The fluidized bed dryers are suitable for crystals, granules, and short fibres, for example, rayon staple, salt crystals, sand, ores, and synthetic rubber.

These are not applicable for large solids, and special forms and shapes, such as pottery, brick, and rayon cakes.

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